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GB 1283111
GB 1177239
GB 0813411
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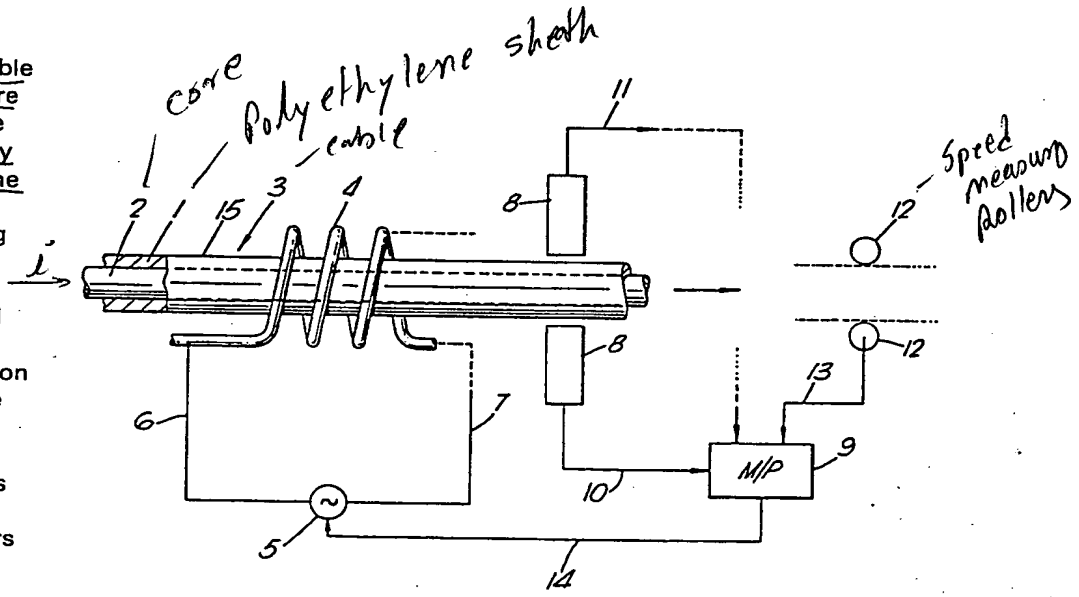
(54) Testing of electric cable

(57) The covering (1) of an electric cable (3) is tested by raising the temperature of the conductive core (2) of the cable by means of an induction coil (4) or by passing an electric current through the core, and detecting the infra-red radiation emerging from the covering (1) with sensors (8). The cable (3) is moved past the sensors (8) and variations in the IR radiation detected thereby are interpreted by a microprocessor (9) to give an indication of the condition of the covering of the cable. Voids or foreign bodies entrapped in the plastics insulating sheath of an electric cable and defects such as scratches or voids in the enamel coatings of electric conductors may be detected in this way.



* passing a current through core (2) of cable (3) to test cover (1).
* Detecting infra-red radiation with sensor (8)
* Microprocessor (9) to interpret variations in IR

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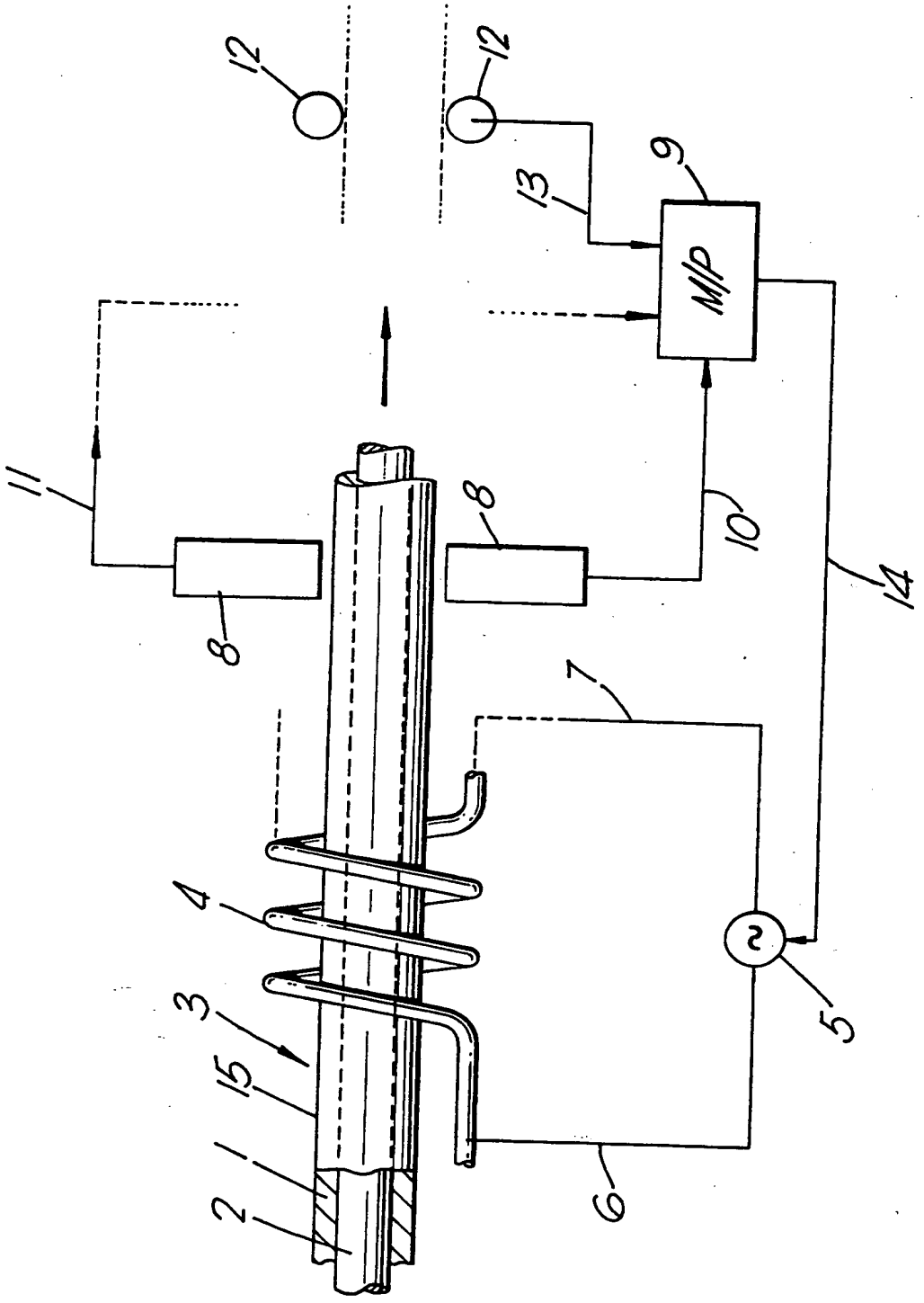
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SPECIFICATION

Testing of electric cable

This invention relates to a method and apparatus for indicating the condition of the covering of a conductive element such as an electric cable. By the term 'covering' is herein meant any material surrounding the conductive core of the element, for example a sheath of insulating material such as polyethylene or PVC, or a coating of enamel or the like. The term 'core' is herein meant to include any conductive material within the covering, whether centrally or non centrally positioned therein, and may even include twisted strands of conductors.

West German Published Application DE3318345A describes one type of apparatus for investigating the condition of a cable covering. In this apparatus a beam of light is directed on to the surface of the cable and the amplitude of the reflected beam is detected. Whilst being able to detect irregularities on the surface of a cable, this apparatus is unable to detect any change in the internal condition of the covering.

The present invention provides a method and apparatus capable of a more comprehensive investigation into the condition of the covering of a conductive element.

Accordingly there is provided apparatus for indicating the condition of the covering of a conductive element comprising heating means for raising the temperature of the conductive core of the element relative to the covering such that the temperature of the core is above that of the ambient temperature; and one or more infra-red sensors adapted to detect infra-red radiation emerging from the covering of the element. Preferably the apparatus includes electronic processing means adapted to receive signals from the one or more infra-red sensors, and to monitor the amplitude of said signals to give an indication of the condition of the covering of the element.

Insulating coverings of plastics material are relatively transparent to infra-red radiation. However, the amount of infra-red radiation escaping from the covering may be reduced in the event of foreign bodies being entrapped in or on the surface of the material, or by a sudden increase in thickness of the covering. Conversely, the amount of I.R. emerging will be increased by a sudden decrease in the thickness of the material. In the event of voids being present in the material the amount of IR emerging may be increased or decreased depending on the transmitivity of any gas contained therein. In any event a change in the condition of the covering, either internal or external, should result in a varying of the amplitude of the signal detected by the one or more sensors.

The above described apparatus may also be employed in the case wher a conductive element is coated with a material substantially impervious to infra-red radiation. Any defects in the coating such as scratches, voids etc will allow an increased level of infra-red radiation to escape from the element which will be detected by the one or more s nsors thereby identifying the defects. A frequently produced type of cable has an insulating sheath of plastics material with an outer lacquered coating, substantially impervious to infra-red radiation. The present invention is particularly suited for the testing of such cable.

There is preferably provided means for effecting relative movement between the conductive element and the one or more sensors. Conveniently the means for effecting movement comprises drive means for producing longitudinal movement of the element, the one or more infra-red sensors being in predetermined stationary location with respect thereto. This arrangement allows a continuous check to be formed on a length of cable, for example as it is being wound on to a spool or drum.

There is preferably provided a plurality of infra-red sensors radially disposed around the circumference of the conductive element. By the provision of a number of sensors, a more thorough check around the circumference of the element may be performed. The degree of precision is only finally determined by the physical constraints of locating the sensors around the element.

Preferably the heating means is adapted to raise the temperature of the conductive core without substantially raising the temperature of the covering of the element. Conveniently the heating means is an induction coil. An inductive heating means is advantageous in that it is a non-contact method, especially suited to a continuous testing function. In addition the heating effect produced by an induction coil is localised and therefore can be controlled to avoid any significant increase in the temperature of the covering of the conductive element.

Alternatively the heating means comprises a DC source connected to the conductive core of the element at two spaced positions along its length, such that an electric current flows therebetween.

Where there is provided drive means for producing longitudinal movement of the element, there is conveniently further provided means for measuring the speed of the element. The electronic processing means, where provided, may therefore conveniently be adapted to receive signals from this speed measuring means and to control the heating means in response to said signals. The heating means may, in this manner, be increased in response to an increase in the speed of the element to allow for the fact that a corresponding portion of the element may be adjacent the heating means (for example in the case where it comprises an induction coil) or the one or more sensors, for a shorter period of time.

The invention further resides in a method of indicating the condition of the covering of a conductive element comprising the steps of raising the temperature of the conductive core of the element relative to the covering such that the temperature of the core is above that of the ambient temperature, and detecting the infra-red radiation emerging from the covering of the element with infra-red sensing means. Preferably the method includes the additional step of effecting relative movement b -

tween the conductive element and the infra-red sensing means. Conveniently the temperature of the core is raised by inducing therein an electric current by means of an induction coil.

One embodiment of the invention will now be further described, by way of example only, with reference to the accompanying drawing which is a schematic view of an apparatus according to the invention.

With reference to the figure, the apparatus is employed to give an indication of the condition of the polyethylene sheath 1 surrounding the conductor core 2 of a cable 3. The cable 3 is drawn longitudinally through the apparatus by drive means (not shown). The apparatus comprises heating means in the form of an induction coil 4 through which the cable 3 is arranged to pass, the coil being connected to a high frequency AC power source 5 by means of lines 6 and 7 attached to opposite ends of the coil 4. The coil 4 is hollow and contains a liquid coolant (not shown) which is pumped therethrough.

Downstream of the heating coil 4 is a plurality of infra-red sensors 8, radially disposed around the cable 3. The sensors 8 are connected to a microprocessor 9 by means of lines 10, 11 etc. Further downstream of the apparatus is a pair of line speed measuring rollers 12, signals from which are fed to the microprocessor 9 by means of line 13. The microprocessor 9 also controls the AC power source 5 by means of electronic signals sent thereto via line 14.

In use the induction coil 5 raises the temperature of the conductive core 2 such that infra-red radiation permeates outwardly through the insulating sheath 1. The amount of infra-red radiation escaping from the surface of the sheath is detected by the sensors 8. Defects in the polyethylene sheath 1 are identified as variations in the infra-red radiation reaching the detectors 8 and hence a variation in the amplitude of the signal received by the microprocessor 9. Any change in the line speed of the cable is detected by the roller 12 and fed to the microprocessor 9. The microprocessor accordingly compensates for the change in line speed in its calculations regarding the cable condition and may additionally adjust the AC power source 5 in response thereto.

The identical apparatus may be employed to give an indication of the condition of the surface of the cable 3 where the insulating sheath 1 is covered by a protective lacquered coating 15. As the coating is much more resistive to the transmission of infra-red radiation than the sheath 1, any scratches etc in the coating 15 will show up as a jump in the amount of infra-red as detected by the sensors 8.

It will be appreciated that the apparatus can easily be made adjustable to accommodate cables having a variety of differing diameters. The coil 4 and sensor 8, although shown in the figure to be adjacent the surface of the cable 3, may easily be spaced radially therefrom a small distance t allow for cables having a variety of diameters to be investigated.

CLAIMS

1. Apparatus for indicating the condition of the covering of a conductive element comprising heating means for raising the temperature of the conductive core of the element relative to the covering such that the temperature of the core is above that of the ambient temperature; and one or more infra-red sensors adapted to detect infra-red radiation emerging from the covering of the element.

2. Apparatus according to Claim 1 including electronic processing means adapted to receive signals from the one or more infra-red sensors, and to monitor the amplitude of said signals to give an indication of the condition of the covering of the element.

3. Apparatus according to Claim 1 or Claim 2 wherein there is provided means for effecting relative movement between the conductive element and the one or more sensors.

4. Apparatus according to Claim 3 wherein the means for effecting movement comprises drive means for producing longitudinal movement of the element, the one or more infra-red sensors being in predetermined stationary location with respect thereto.

5. Apparatus according to any of Claims 1 to 4 comprising a plurality of infra-red sensors disposed radially around the circumference of the conductive element.

6. Apparatus according to any of Claims 1 to 5 wherein the heating means is adapted to raise the temperature of the conductive core without substantially raising the temperature of the covering of the element.

7. Apparatus according to any of Claims 1 to 6 wherein the heating means is an induction coil.

8. Apparatus according to any of Claims 1 to 6 wherein the heating means comprises a DC sourc connected to the conductive core of the element at two spaced positions along its length, such that an electric current flows therebetween.

9. Apparatus for indicating the condition of the covering of a conductive element comprising heating means for raising the temperature of the conductive core of the element above that of the ambient temperature; one or more infra-red sensors adapted to detect infra-red radiation emerging from the covering of the element; drive means for producing longitudinal movement of the element with respect to the one or more sensors; means for measuring the speed of the element; and electronic processing means adapted to receive signals from the one or more infra-red sensors, and to monitor the amplitude of said signals to give an indication of the condition of the covering of the conductive element.

10. Apparatus according to Claim 9 wherein the electronic processing means is additionally adapted to control the heating means in response to signals received from the speed measuring means.

11. Apparatus substantially as hereinbefore described with reference to the accompanying drawing.

12. A method of indicating the condition of the covering of a conductive element comprising the steps of raising the temperature of the conductive core of the element relative to the covering such that the temperature of the core is above that of the ambient temperature, and detecting the infra-red radiation emerging from the covering of the element with infra-red sensing means.

13. A method according to Claim 12 including the additional step of effecting relative movement between the conductive element and the infra-red sensing means.

14. A method according to Claim 12 or Claim 13 wherein the temperature of the core is raised without substantially raising the temperature of the covering of the element.

15. A method according to any of Claims 12 to 14 wherein the temperature of the core is raised by inducing therein an electric current by means of an induction coil.

16. A method according to any of Claims 12 to 15 and substantially as hereinbefore described.

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